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On the creation of infinitesimal mechanisms through cellular morphogenesis

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Abstract

In a structure, an infinitesimal mechanism represents a set of nodal displacements that do not engender extensions in its members. Tensegrity structures are self-stressed frameworks where the connectivity of the members and the configuration of nodes control the number of self-stress states and infinitesimal mechanisms in the system. In literature, kinematic analysis of tensegrity structures reveals infinitesimal mechanisms as an advantageous motion control strategy minimizing the control energy. However, infinitesimal mechanism creation is typically not controlled during the form finding and design of tensegrity structures. This paper is a continuation to the study of how the topology and geometry of tensegrity systems affects the creation of self-stress states through the cellular morphogenesis principles. In this paper, it is shown that infinitesimal mechanisms are created when fusion with the removal of two edges from the same two cells is used to compose the structure. A systematic method for the description of the infinitesimal mechanisms' modes at each step of the generation process, similar to the description of self-stress states in the fusion and adhesion processes, is proposed. The proposed method enables the design of tensegrity structures with predefined motion abilities that can be of great importance to deployable and reconfigurable tensegrity applications.

Key words

Tensegrity, self-stressed frameworks, finite mechanism, infinitesimal mechanism, self-stress, design, control, cellular morphogenesis, form finding.